

STRENGTH & COST ANALYSISE OF CONCRETE BY PARTIAL REPALACEMENT OF CEMENT

¹Mr. Ghanshyam Pal

Assistant Professor

Department of Civil Engineering, Thakur College of Engineering & Technology, Kandivali East,

Emailid-ghanshyamp89@gmail.com INDIA

Abstract—The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and the global warming.

The search for any such material, which can be used as an alternative or as a supplementary for cement so we had taken a research for partial replacement of cement by combine mixing of GGBS, FLY-ASH & SILICA FUME in a constant percentage and studying the effect of special material on concrete as well as cost analysis of concrete.

I. INTRODUCTION

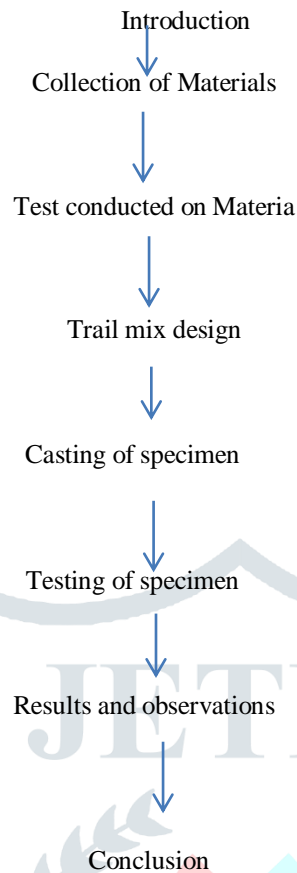
Concrete has basic naturally, cheaply and easily available ingredients as cement, sand, aggregate and water. After the water, cement is second most used material in the world. But this rapid production of cement creates two big environmental problems for which we have to find out civil engineering solutions. First environmental problem is emission of CO₂ in the production process of the cement. We know that CO₂ emission is very harmful which creates lots of environmental changes whatsoever.

Ground Granulated Blast furnace slag (GGBS) is a by-product for manufacture of pig iron and obtained through rapid cooling by water or quenching molten slag. Here the molten slag is produced which is instantaneously tapped and quenched by water. This rapid quenching of molten slag facilitates formation of “Granulated slag”. Ground Granulated Blast furnace Slag (GGBS) is processed from Granulated slag. Fly ash is one of the residues created during the combustion of coal in coal-fired power plants. Fine particles rise with flue gasses and are collected with filter bags or electrostatic precipitators. Silica Fume is a finely-divided mineral admixture, available in both uncompact and compacted forms. This ultra-fine material will better fill voids between cement particles and result in a very dense concrete with higher compressive strengths and extremely low permeability.

II METHODOLOGY

The study work is to analyses strength properties of partially replaced by GGBS, FLY-ASH, and SILIKAFUME concrete. The tests of concretes are carried out as per IS code for this proposed investigation work.

Steps for Trial...



III PROPERTIES OF INGREDIENTS

I.1 Cement

The cements used in this experimental works are ordinary Portland cement. All properties of cement are tested by referring IS Specification for Ordinary Portland cement. Test results are presented in Table

SR.NO.	DISCRIPTION OF TEST	RESULT
01	Fineness of test	1%
02	Specific gravity	3.15
03	Standard consistency of cement	35%
04	Setting time of cement a) Initial setting time b) Final setting time	90minute 360minute
05	Soundness test of cement (with le –chatlear apparatus)	1.5mm

Table3.1. Physical Properties of Cement (Confirming to IS 12269-1987)

IV. TESTING OF MIX DESIGN

Result Of Trail Mix (observations and test Results)

- a) Workability targeted (in mm)
- b) Workability observed (in mm)
- c) Remarks
- d) Corrections
- e) Cohesiveness: Remarks
- c) Compressive Strength (Average of Three Test Cubes)
 - i) 3 day (kg/ cm²) 26.216 N/MM²
 - ii) 7 day (kg/ cm²) 32.148 N/MM²
 - iii) 28 day (kg/ cm²) 36.26 N/MM²

HENCE THIS GIVE RESULT OF MIX DESIGN FOR CONTROL CONCRETE

RATIO (1: 1.47 : 1.9) WITH 28 DAYS STRENGTH 36.26 N/MM²

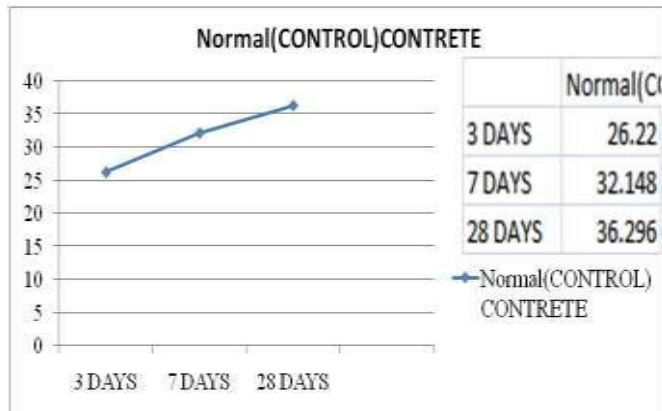


Fig.IV.1: Graph. Days v/s strength(n/mm²)

V. Flexural strength test.

The arrangement for flexural strength test is shown in Figure. Automatic universal testing machine was used for this test according to BS1881-118 [12] Beam samples measuring 500×100×100mm were moulded and stored in water for 28days before test for flexural strength. Three similar samples were prepared for each mix proportion. The casting was made by filling Each mould with freshly mixed concrete in three layers. Each layer was compacted manually using a 16 mm diameter steel tamping rod to give 25 strokes on a layer.

The hardened beam was placed on the universal testing machine simply supported over a span 3times the beam depth on a pair of supporting rollers. Two additional loading rollers were place

on top the beam. The load was applied without shock at a rate of 200m/s. The flexural strength was then calculated using

$$F_{cl} = \frac{PL}{D_1 D_2}$$

Where,

P = breaking load (in N);

D₁ and D₂ = lateral dimensions of the cross sections (In mm);

L = distance between the supporting rollers (In mm)

2. STRENGTH OF CONCRETE HAVING CEMENT CONSTANT ie 60%

Comparison of control concrete strength with constant cement (50%) replacement strength

Table2.1 Strength of control concrete with replacement of constant cement

Cement replacement with 60% give optimum result at (20%g:10%f:10%si) replacement i.e. 34.00mpa

COST OF INGREDIENTS PER KG AS PER MARKET RATE IN ASANGAON (Table 2.1)

DAYS / STRENGTH(Mpa)	SLUMP(MM)	3DAYS	7 DAYS	28 DAYS
NORMAL CONCRETE (CONTROL CONCRETE (1:1.47:1.9)	75	26.22Mpa	32.148Mpa	36.296Mpa
Cement replacement (20:10:10) CEMENT 60%	65	14.22Mpa	24.59Mpa	34.00Mpa
Cement replacement (20:10:10) CEMENT 50%	80	17.77Mpa	20.00Mpa	29.55Mpa
Cement replacement (20:10:10) CEMENT 50%	75	12.00Mpa	20.11Mpa	29.5Mpa

2.1. STRENGTH OF CONCRETE HAVING CEMENT CONSTANT ie. 70%

Comparison of control concrete strength with constant cement (70%) replacement strength

Table 2.2. Strength of control concrete with replacement of constant cement

Cement Replacement with 70% give optimum result at (10%G:10%F:10%Si) Replacement i.e. 34.51mpa

Cost of Ingredients Per kg as per Market Rate in Asangaon

G.G.B.S - 2.90 RS / KG

DAYS / STRENGTH (Mpa)	SLUMP(MM)	3 DAYS	7DAYS	28 DAYS
NORMAL CONCRETE (CONTROL CONCRETE (1:1.47:1.9))	75	26.22 Mpa	32.148Mpa	36.296Mpa
Cement replacement (10:10:10) CEMENT 70%	70	17.185Mpa	32.07Mpa	34.00Mpa
Cement replacement (10:10:10) CEMENT 70%	70	17.085Mpa	24.07Mpa	34.00Mpa
Cement replacement (10:10:10) CEMENT 70%	70	17.19Mpa	20.11Mpa	34.00Mpa

FLY-ASH - 2.75 RS/ KG

SILICA - FUME - 25 RS/ KG

CEMENT - 8.00 RS/ KG

AS SILIKA -FUME IS TOO MUCH COSTLY HENCE AVOID THE MAXIMUM REPLACEME OF SILICA-FUME

Comparison of control concrete strength with constant cement (70%) replacement strength

Cost of Ingredients Per kg as per Market Rate in ASANGAON

G.G.B.S - 2.90 RS / KG

FLY-ASH - 2.75 RS/ KG

SILICA - FUME - 25 RS/ KG

CEMENT - 8.00 RS/ KG

as silica -fume is too much costly hence avoid the maximum replacement of silica-fume

1. QUANTITY & COST FOR NINE (09) CUBE FOR THE TESTING (20G:10F:10Si) ie 60% CONSTANT CEMENT**TOTAL QUANTITY = 0.0513 M³**

CEMENT IN KG = 16.77 KG

SAND IN KG = 24.65 KG

AGGRIGATE IN KG = 15.93 KG(M1)

15.93 KG(M2)

TOTALAGGRIGATE =31.86KG

COST FOR THE SAND = 24.65 X 1.32= 32.53 Rs. Ie 33.00 Rs

COST FOR THE AGGRIGATE = 31.86 X 1.1 = 35.046 Rs. Ie 36 Rs.

COST FOR CEMENT IN (20:10:10) CASE ie 60%constant cement.

Total weight of cement =16.77 k

But 60% cement =0.6x16.77 = 10.062 kg

Hence cost of cement (20:10:10) = 10.062 x 8 = 80.496 Rs ie 81.00 Rs.

REMAINING 40% HAVE (20% GGBS, 10% FLY-ASH, 10% SILIKA- FUME)

20% GGBS = 0.2 X16.77 = 3.354 KG

COST FOR GGBS = 3.354 x 2.90 = 9.7266 Rs.

10% FLY-ASH = 0.1 X 16.77= 1.677 KG

COST FOR FKY- ASH = 1.677 X 2.75 = 4.611Rs.

10% SILIKA- FUME = 0.1 X 16.77 = 1.677 KG

COST FOR SILIKA- FUME = 1.677 X 25 = 41.92 Rs.

Hence total cost for material for (20:10:10) replacement

= 33+36.00+ 81.00 + 9.7266 + 4.611 + 41.92

= 206.2626 Rs. (for 20:10:10)Hence total cost / m³4020.66 Rs. / m³**2 QUANTITY & COST FOR NINE (09) CUBE FOR THE TESTING (10G:10F:10Si) ie 70% CONSTANT CEMENT.****TOTAL QUANTITY = 0.0513 M³**

CEMENT IN KG = 16.77 KG

SAND IN KG = 24.65 KG

AGGRIGATE IN KG = 15.93 KG(M1)

15.93 KG(M2)

TOTAL AGGRIGATE =31.86KG

COST FOR THE SAND = 24.65 X 1.32= 32.53 Rs. Ie 33.00 Rs**COST FOR THE AGGRIGATE = 31.86 X 1.1 = 35.046 Rs. Ie 36 Rs.**

COST FOR CEMENT IN (20:10:10) CASE ie 70%constant cement

Total weight of cement =16.77 kg

But 70% cement =0.7x16.77 = 11.739 kg

Hence cost of cement (10:10:10) = 11.739 x 8 = 93.912 Rs ie 94.00 Rs.

REMAINING 30% HAVE (10% GGBS, 10% FLY-ASH, 10% SILIKA- FUME)

10% GGBS = 0.1 X16.77 = 1.677 KG

COST FOR GGBS = 1.677 x 2.90 = 4.8633 Rs.

10% FLY-ASH = 0.1 X 16.77= 1.677 KG

COST FOR FKY- ASH = 1.677 X 2.75 = 4.611Rs.

10% SILIKA- FUME = 0.1 X 16.77 = 1.677 KG

COST FOR SILIKA- FUME = 1.677 X 25 = 41.92 Rs.

Hence total cost for material for (10:10:10) replacement

= 33.00 +36.00 + 94 + 4.8633 + 4.611 + 41.92

= 214.3943Rs.Hence total cost / m³4179.22 Rs./ m³

RESULT

Sr. no.	Description of sample	Grade of concrete	Slump (mm)	Compressive Strength at 28 days	Tensile strength (N/mm ²)	Flexural strength (N/mm ²)	Cost (Rs.)/m ³
01	60% constant cement Remaining 40% Have (20% Ggbs, 10% Fly-Ash, 10% Silica- Fume) (60% constant cement) (20%G : 10%F : 10%Si)	M30	70mm	34.00 Mpa	2.053 (N/mm ²)	3.28 (N/mm ²)	4020.66 Rs./ m ³
02	70% constant cement Remaining 40% Have (10% Ggbs, 10% Fly-Ash, 10% Silica- Fume) (70% constant cement) (10%G : 10%F : 10%Si)	M30	70 mm	34.00 Mpa	2.92 (N/mm ²)	2.88 (N/mm ²)	4179.22 Rs./ m ³

Comparing Both (20G:10F:10Si) & (10G:10F:10Si) the Replacement cost and strength.

- i) Hence Preferably (20%Ggbs : 10%Fly-Ash : 10%Silica-Fume) are accepted.
- ii) Having 60% Constant Cement Replacement In The Presence Of GGBS, Fly-Ash And Silica-Fume Is Optimum.
- iii) Since The Cost Is Less And Strength Is Very much acceptable, Also cost saving of 158.56 Rs / M³

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